Bacteria

Would you believe that a single gram of soil–which is about the mass of a pencil eraser–may have more than 2.5 billion bacteria? A handful of soil may contain trillions of them!

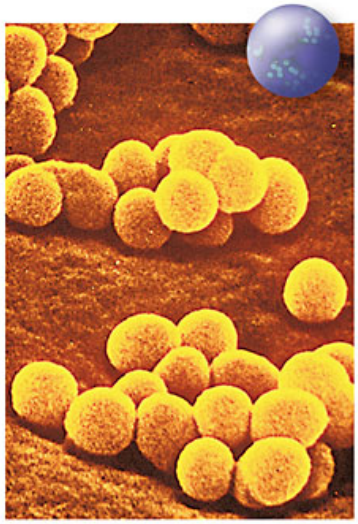
All living things fit into one of three domains: Bacteria, Archaea, or Eukarya. The domain Bacteria consists of single-celled organisms that do not have a nucleus and has more individuals than all other domains combined. Members of the domain Bacteria live in soil, water, and other organisms. The domain Bacteria consists of some of the oldest forms of life on Earth, about 3.5 billion years!

Some Characteristics of Bacteria

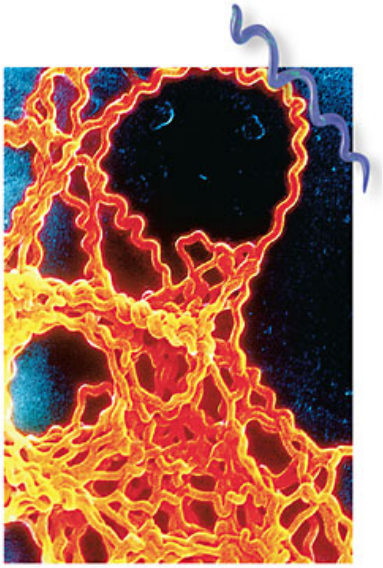
There are more bacteria on Earth than there are all other living things combined. Most bacteria are too small to be seen without a microscope. But not all bacteria are the same size. In fact, the largest known bacteria are 1,000 times as large as the average bacterium. One of these types of giant bacteria was found inside a surgeonfish and can be seen without a microscope!

Members of the domain Bacteria are usually one of three main shapes: rod shaped, spherical, and spiral shaped. Most bacteria have a rigid cell wall that gives them this shape. The photos below show the three most common shapes of bacteria. Bacilli are rod shaped. Cocci are spherical. Spirilla are long and spiral shaped. Each shape helps bacteria in a different way.

Bacilli (buh SIL IE) are rod shaped. They have a large surface area, which helps them take in nutrients. But a large surface area can cause them to dry out easily.



Cocci (KAHK SIE) are spherical. They do not dry out as quickly as rod-shaped bacteria.



Spirilla (spie RIL uh) are long and spiral shaped. They use flagella at both ends to move like a corkscrew.

Some bacteria have hairlike parts called *flagella* that help them move around. Flagella spin to push a bacterium through water or other liquids.

No Nucleus!

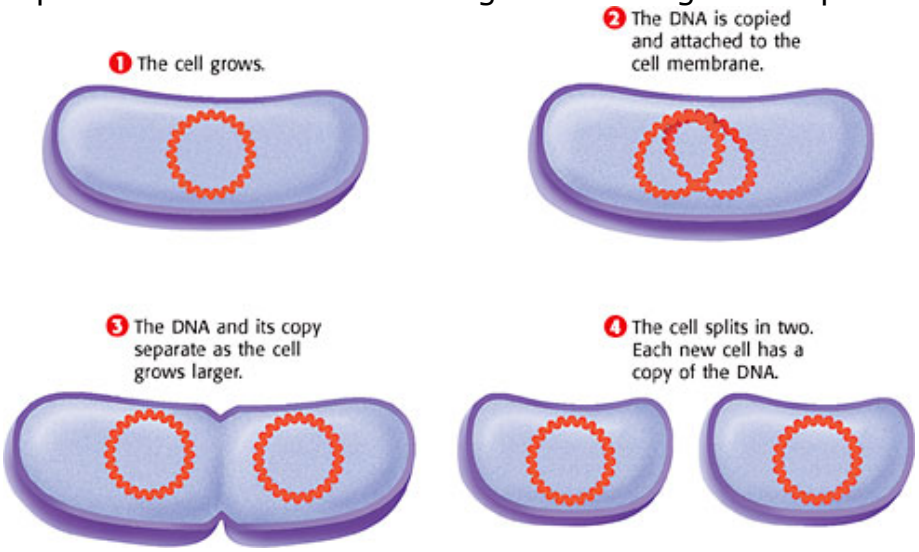
All bacteria are single-celled organisms that do not have a nucleus, known as a **prokaryote**. A prokaryote is able to move, get energy, and reproduce like cells that

have a nucleus, which are called *eukaryotes*.

Prokaryotes function as independent organisms. Some bacteria stick together to form strands or films, but each bacterium is still functioning as a single organism. Most prokaryotes are much simpler and smaller than eukaryotes. Prokaryotes also reproduce differently than eukaryotes do.

Prokaryote Reproduction

Bacteria reproduce by the process below, called binary fission. **Binary fission** is reproduction in which one single-celled organism splits into two single-celled organisms.



Classification of Bacteria

Bacteria are classified in part by the way they get food. Most bacteria, such as those that break down leaves, are consumers. Consumers get their food by eating other organisms. Many bacteria are decomposers, which feed on dead organisms. Other bacterial consumers live in or on the body of another organism. Bacteria that make their own food are called *producers.* These bacteria use energy from sunlight to make food and are often green.

Humans couldn't live without bacteria, but bacteria can also cause harm. Scientists learned in the 1800s that some bacteria are pathogenic. **Pathogenic bacteria** are bacteria that cause disease. Pathogenic bacteria get inside a host organism and take nutrients from the host's cells. In the process, they harm the host. Today, we are protected from many bacterial diseases by vaccination**.** Many bacterial diseases can also be treated with antibiotics.

Diseases in Other Organisms

Bacteria cause diseases in other organisms as well as in people. Have you ever seen a plant with odd-colored spots? If so, you've seen bacterial damage to plants. Pathogenic bacteria attack plants, animals, protists, fungi, and even other bacteria. They can cause damage to grain, fruit, and vegetable crops. Plants are sometimes treated with antibiotics. Scientists have also genetically engineered certain plants to be resistant to disease-causing bacteria.

Viruses

A **virus** is a microscopic particle that gets inside a cell and often destroys the cell. Many viruses cause diseases, such as the common cold, flu, and acquired immune deficiency syndrome (AIDS).

It's a Small World

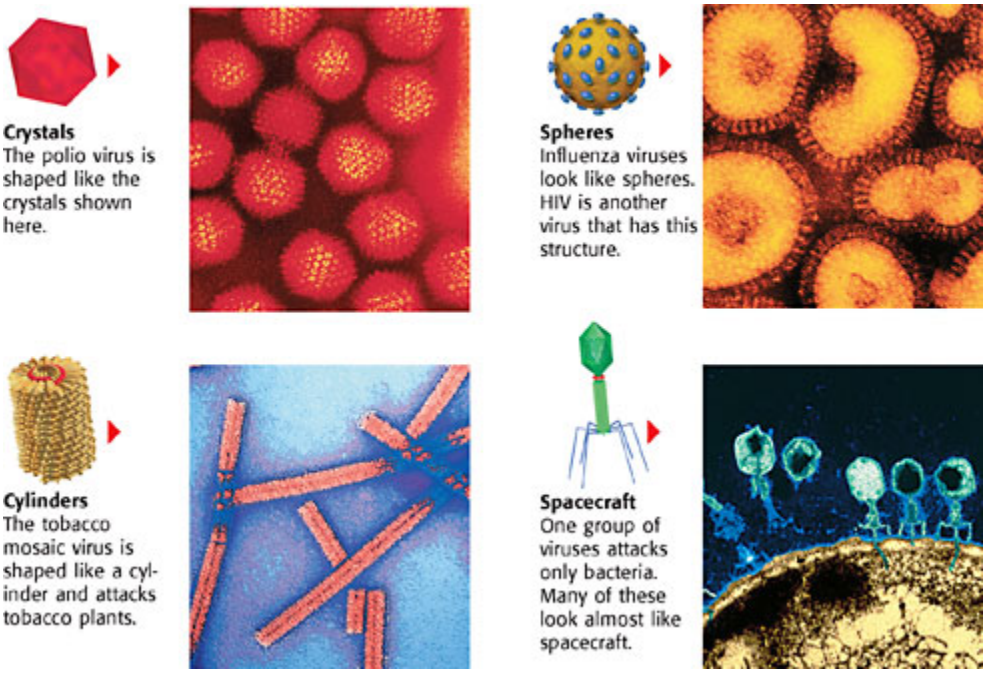
Viruses are tiny. They are smaller than the smallest bacteria. About 5 billion virus particles could fit in a single drop of blood. Viruses can change rapidly. So, a virus's effect on living things can also change. Because viruses are so small and change so often, scientists don't know exactly how many types exist. These properties also make them difficult to fight.

Are Viruses Living?

Like living things, viruses contain protein and genetic material. But viruses don't act like living things. They can't eat, grow, break down food, or use oxygen. Viruses are not cells. They do not have cytoplasm or organelles. In fact, a virus cannot function on its own. A virus can reproduce only inside a living cell that serves as a host. A **host** is a living thing that a virus or parasite lives on or in. Using a host's cell as a tiny factory, the virus forces the host to make viruses rather than healthy new cells.

Classifying Viruses

Viruses can be grouped by their shape, the type of disease they cause, their life cycle, or the kind of genetic material they contain. The four main shapes of viruses are shown in **Figure 2.** Every virus is made up of genetic material inside a protein coat. The protein coat protects the genetic material and helps a virus enter a host cell. Many viruses have a protein coat that matches characteristics of their specific host.



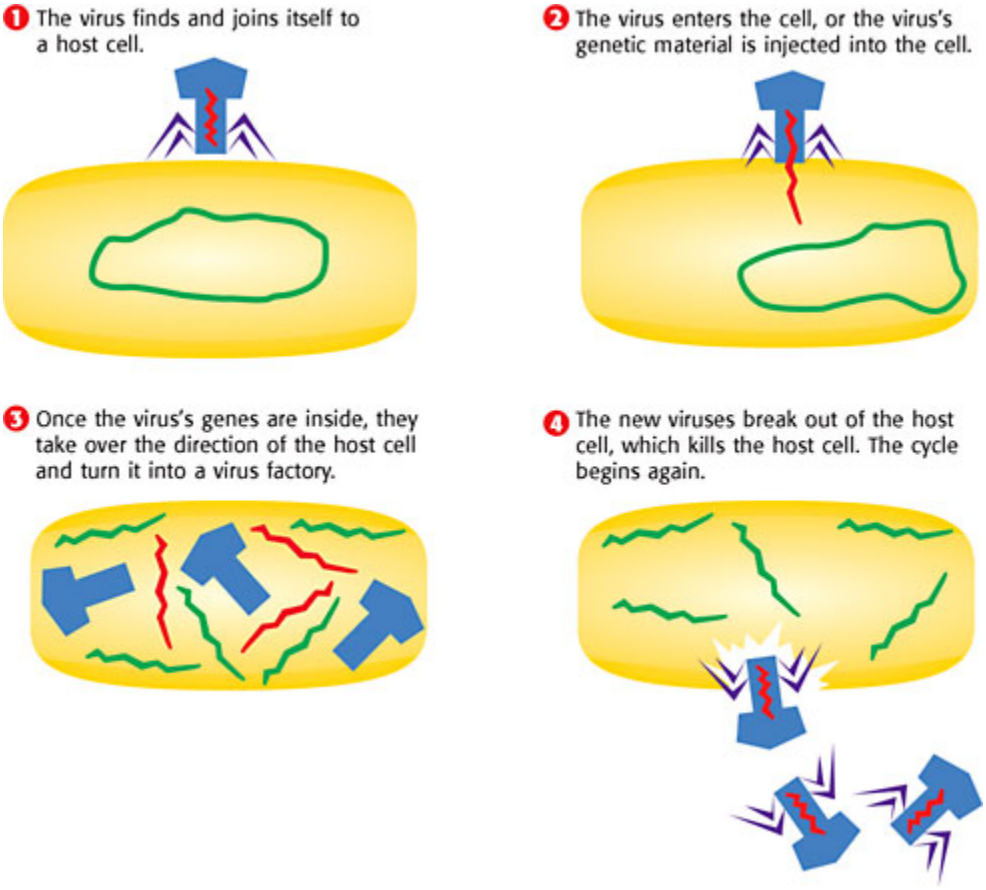
Crystals
The polio virus is shaped like the crystals shown here.

Spheres
Influenza viruses look like spheres. HIV is another virus that has this structure.

Cylinders
The tobacco mosaic virus is shaped like a cylinder and attacks tobacco plants.

Spacecraft
One group of viruses attacks only bacteria. Many of these look almost like spacecraft.

The one thing that viruses do that living things also do is make more of themselves. Viruses attack living cells and turn them into virus factories. This cycle is called the *lytic cycle*.



Treating a Virus

Antibiotics do not kill viruses. But scientists have recently developed antiviral medications. Many of these medicines stop viruses from reproducing. Because many viral diseases do not have cures, it is best to prevent a viral infection from happening in the first place. Childhood vaccinations give your immune system a head start in fighting off viruses. Having current vaccinations can prevent you from getting a viral infection. It is also a good practice to wash your hands often and never to touch wild animals. If you do get sick from a virus, it is often best to rest and drink extra fluids.

Parasites

Parasites are living things that use other living things - like your body - for food and a place to live. You can get them from contaminated food or water, a bug bite, or sexual contact. They may be transmitted from animals to humans, from humans to humans, or from humans to animals.

Parasites range in size from tiny, one-celled organisms called protozoa to worms that can be seen with the naked eye – up to two meters long! The illnesses they can cause range from mild discomfort to debilitating illness and possibly death.

Several parasites have emerged as significant causes of foodborne and waterborne illness. These organisms live and reproduce within the tissues and organs of infected human and animal hosts, and are often excreted in feces. If you are traveling, it's important to drink only water you know is safe. Prevention is especially important. There are no vaccines to prevent parasitic diseases, but some medicines are available to treat parasitic infections.

In humans, there are three main disease causing parasite categories: protozoa, helminthes, and ectoparasites.

Protozoa are single-celled free-living or parasitic organism, with an ability to multiply in humans. This capacity not only contributes to their survival, but it takes only one to cause a very serious infection.

Intestinal living protozoa are typically transmitted via consumption of fecal matter, by way of contaminated food, water or personal contact. Those living in your environment are commonly transmitted by way of a bite from a fly, mosquito, sand fly, etc.

Helminths, or worms, are multi cellular free-living or parasitic organisms, which are generally large enough to be seen. In their adult form, they cannot multiply in humans. The three main human parasite worm groups include:

flatworms ~ flukes & tapeworms

thorny-headed worms ~ adult forms reside in your gastrointestinal tract

roundworms ~ adult forms can reside in your gastrointestinal tract, blood, lymphatic system or subcutaneous tissues, while in their immature state can cause body tissue infections

Segmented worms, like leeches, are sometimes considered in this helminths group.

Ectoparasites burrow into your skin and can remain there for relatively long periods of time, in some cases months. These infectious disease causing parasites include: Lice, Fleas, Ticks, Mites

Blood-sucking arthropods, such as mosquitoes, may broadly be included. Arthropods can cause diseases on their own, but more importantly, they are carriers transmitting

numerous disease causing pathogens. These carried pathogens cause the highest proportion of infectious diseases, in some cases resulting in death with diseases like malaria, yellow fever, dengue fever, and West Nile virus

Parasitic infections cause a tremendous disease burden. On a global scale, malaria causes the most deaths, killing about a million people every year.

Common parasites

Giardia

Giardia duodenalis, cause of giardiasis is a one-celled, microscopic parasite that can live in the intestines of animals and people. It is found in every region throughout the world and has become recognized as one of the most common causes of waterborne (and occasionally foodborne) illness in the United States. People often get giardia through drinking infected water, and find diarrhea, abdominal cramps, gas, and nausea are the most common symptoms. Chronic infection might lead to dehydration and severe weight loss.

Trichinella spiralis

Trichinella spiralis, cause of trichinellosis (also known as **trichinosis**) (TRICK-a-NO-sis) is an intestinal roundworm whose larvae may migrate from the digestive tract and form cysts in various muscles of the body. Infections occur worldwide, but are most prevalent in regions where pork or wild game is consumed raw or undercooked. The incidence of trichinosis has declined in the United States due to changes in hog feeding practices. Presently, most cases in this country are caused by consumption of raw or undercooked wild game. The illness is **not** spread directly from person to person.

The first symptoms are nausea, diarrhea, vomiting, fever, fatigue, and abdominal pain, followed by headaches, eye swelling, aching joints and muscles, weakness, and itchy skin. In severe infections, persons may experience difficulty with coordination and have heart and breathing problems. Death may occur in severe cases.

***Taenia saginata/Taenia solium* (Tapeworms)**

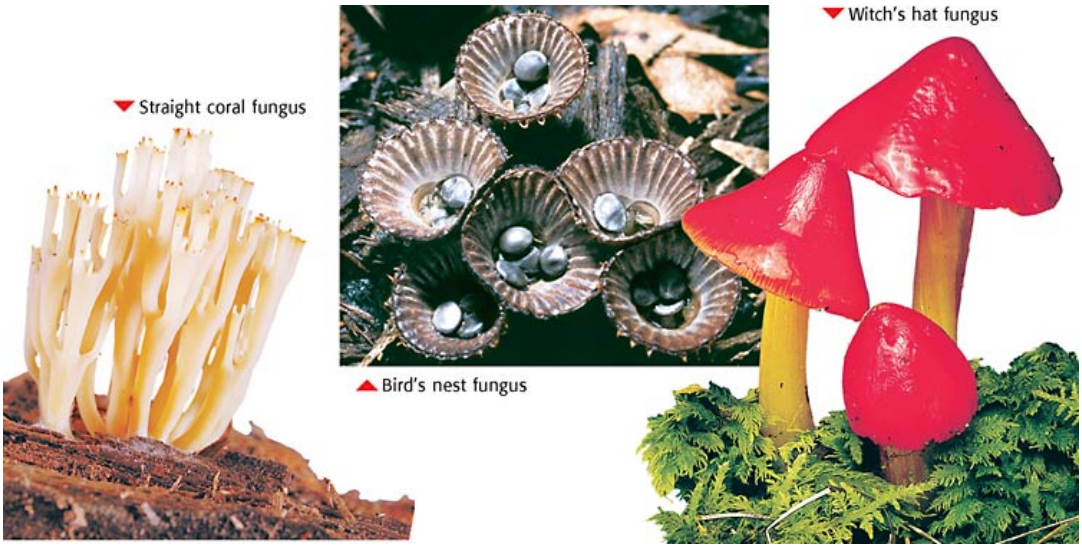
Taenia saginata (beef tapeworm) and *Taenia solium* (pork tapeworm) are parasitic worms (helminths). **Taeniasis** is the name of the intestinal infection caused by adult-stage tapeworms (beef or pork tapeworms).

It is interesting to note that humans are the **definitive hosts** of both organisms. This means that the reproductive cycle, and thus egg production by the organisms, occurs only within humans. Eggs are passed in human feces and they may be shed into the environment for as long as the worms remain in the intestines (for as long as 30 years).

Fungi

Characteristics of Fungi

Fungi have rigid cell walls and no chlorophyll. They are so different from other organisms that they are placed in their own kingdom. As you can see in **Figure 1,** fungi come in a variety of shapes, sizes, and colors.

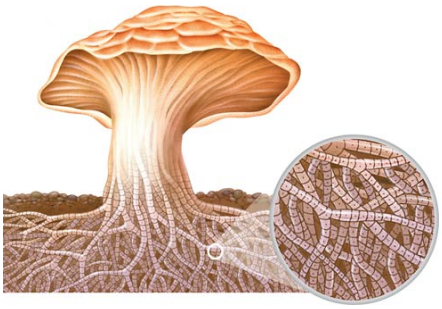


Food for Fungi

Fungi cannot catch or surround food. Fungi must live on or near their food supply. Most fungi are consumers. These fungi get nutrients by secreting digestive juices onto a food source and then absorbing the dissolved food. Many fungi are decomposers, which feed on dead plant or animal matter. Other fungi are parasites.

Some fungi live in mutualism with other organisms. For example, many types of fungi grow on or in the roots of a plant. The plant provides nutrients to the fungus. The fungus helps the root absorb minerals and protects the plant from some disease-causing organisms. This relationship between a plant and a fungus is called a *mycorrhiza* (MIE koh RIE zuh).

Hidden from View



All fungi are made of eukaryotic cells, which have nuclei. Some fungi are single celled, but most fungi are made of many cells. These many-celled fungi are made up of chains of cells called hyphae (HIE fee). Most of the hyphae that make up a fungus grow together to form a twisted mass called the **mycelium**.

Making More Fungi

Reproduction in fungi may be either asexual or sexual. Asexual reproduction in fungi occurs in two ways. In one type of asexual reproduction, the hyphae break apart, and each new piece becomes a new fungus. Asexual reproduction can also take place by the production of spores.

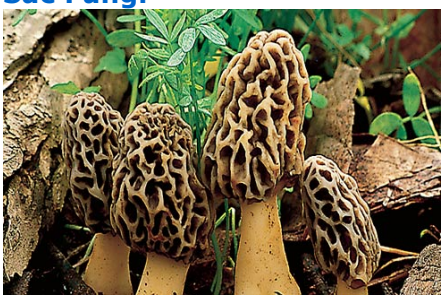
Kinds of Fungi

Fungi are classified based on their shape and the way that they reproduce. There are four main groups of fungi. Most species of fungi fit into one of these groups. These groups are threadlike fungi, sac fungi, club fungi, and imperfect fungi.

Threadlike Fungi

A **mold** is a shapeless, fuzzy fungus. This particular mold belongs to a group of fungi called *threadlike fungi*.

Sac Fungi



Sac fungi are the largest group of fungi. Sac fungi include yeasts, powdery mildews, truffles, and morels.

Most sac fungi are made of many cells. However, *yeasts* are single-celled sac fungi. When yeasts reproduce asexually, they use a process called *budding*. In budding, a new cell pinches off from an existing cell.

Some sac fungi are very useful to humans. For example, yeasts are used in making bread and alcohol. Yeasts use sugar as food and produce carbon dioxide gas and alcohol as waste. Trapped bubbles of carbon dioxide cause bread dough to rise. This process is what makes bread light and fluffy. Other sac fungi are sources of antibiotics and vitamins. And some sac fungi, such as truffles and morels, are prized as human foods. But not all sac fungi are helpful. In fact, many sac fungi are parasites. Some cause plant diseases, such as chestnut blight and Dutch elm disease.

Club Fungi

The umbrella-shaped mushrooms are the most familiar fungi. Mushrooms belong to a group of fungi called *club fungi*. This group gets its name from structures that the fungi grow during reproduction.

The most familiar mushrooms are known as *gill fungi*. Some varieties are grown commercially and sold in supermarkets. However, not all gill fungi are edible. For example, the white destroying angel is a very poisonous fungus. Simply a taste of this mushroom can be fatal.

Imperfect Fungi

The *imperfect fungi* group includes all of the species of fungi that do not quite fit in the other groups. These fungi do not reproduce sexually. Most are parasites that cause diseases in plants and animals. One common human disease caused by these fungi is athlete's foot, a skin disease. Another fungus from this group produces a poison called *aflatoxin* (AF luh TAHKS in), which can cause cancer.

Some imperfect fungi are useful. *Penicillium* is the source of the antibiotic penicillin. Other imperfect fungi are also used to produce medicines. Some imperfect fungi are used to produce cheeses, soy sauce, and the citric acid used in cola drinks.